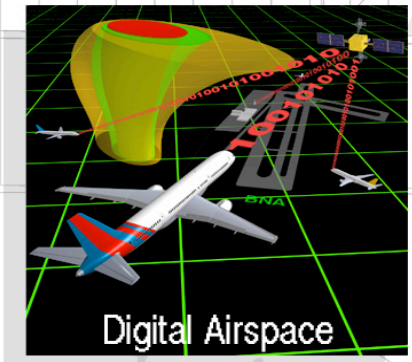
NASA Aerospace Technology Enterprise

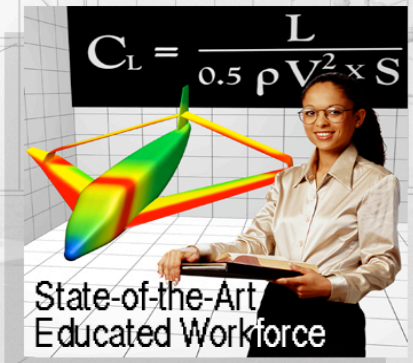
Vehicle Systems Program

Dr. Gary Seng

May 22, 2002

The NASA Aeronautics Blueprint - Toward a Bold New Era of Aviation





NASA Enterprises---From Strategic Plan to Programs

To understand and protect our home planet
To explore the Universe and search for life
To inspire the next generation of explorers
. . . as only NASA can

- Biological and Physical Research
- Earth Science
- Human Exploration and Development of Space
- Space Science
- ***Aerospace Technology***

National Goals

Aerospace Technology Enterprise Programs

- UEET
- Quiet Aircraft
- Flight Research
- 21st Century Aircraft
- *Propulsion & Power*
- Breakthrough Vehicles
- Advanced Vehicle Concepts

- Enabling Concepts & Techs
- Computing, Info & Comm Tech
- Eng for Complex Systems
- Adv Space Trans
- 2nd Gen RLV
- Aerospace Capacity
- Aviation Safety
- ***Vehicle Systems***

Goals & Objectives

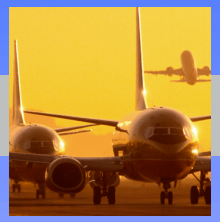
Enterprise Goals & Objectives

Revolutionize Aviation

Increase Safety

Reduce Emissions

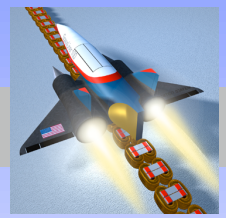
Reduce Noise



Increase Capacity

Increase Mobility

Advance Space Transportation

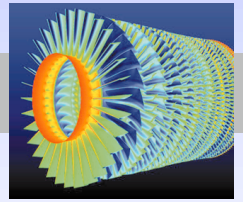


Mission Safety

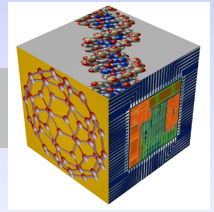
Mission Affordability

Mission Reach

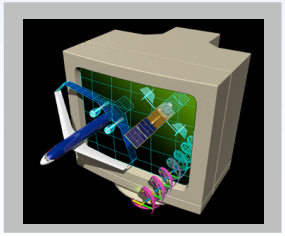
Pioneer Technology Innovation



Engineering Innovation

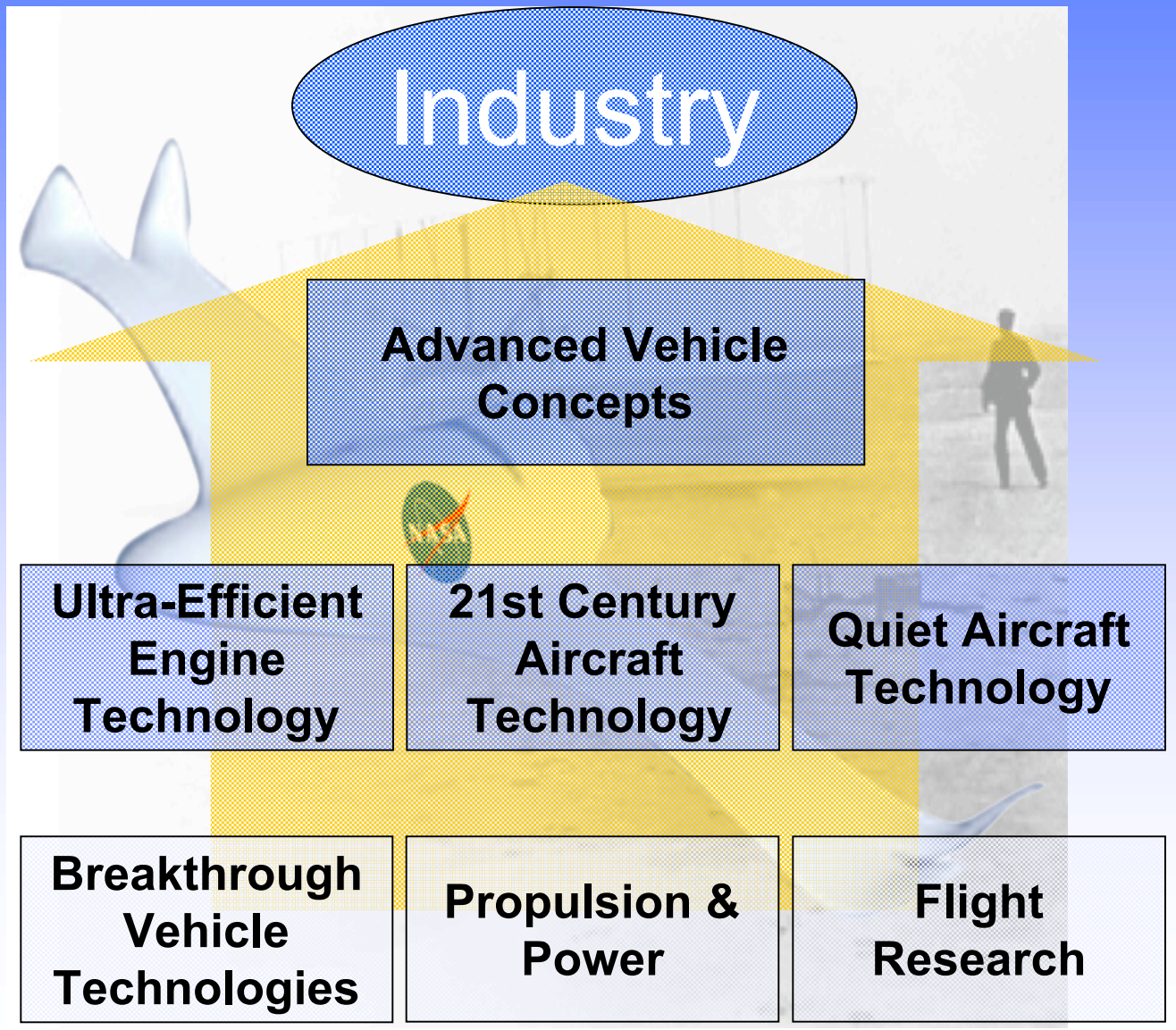


Technology Innovation



Commercialize Technology

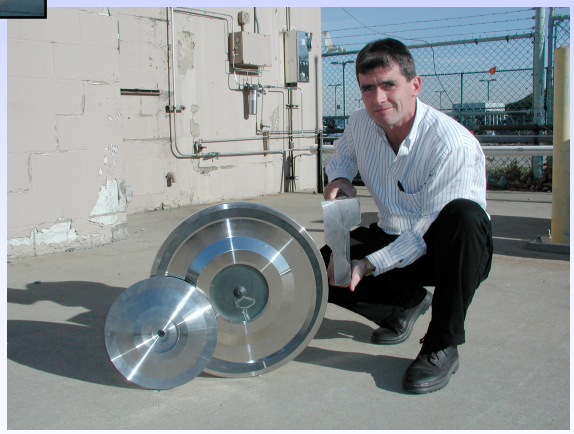
Vehicle Systems



Vehicle Systems - Accomplishments

Quiet Aircraft Technology Flight Test

Helios over the Pacific Ocean

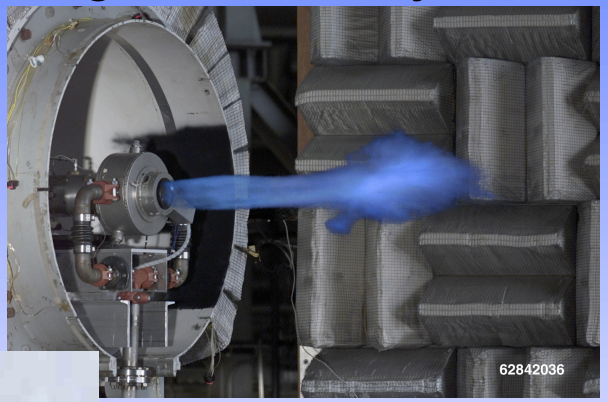


Disk fabricated from NASA disk alloy

Vehicle Systems - Accomplishments

Stitched/Resin Film Infused (S/RFI) Composite Wing Box Successfully Tested

Boeing – Pratt Whitney PDE in test

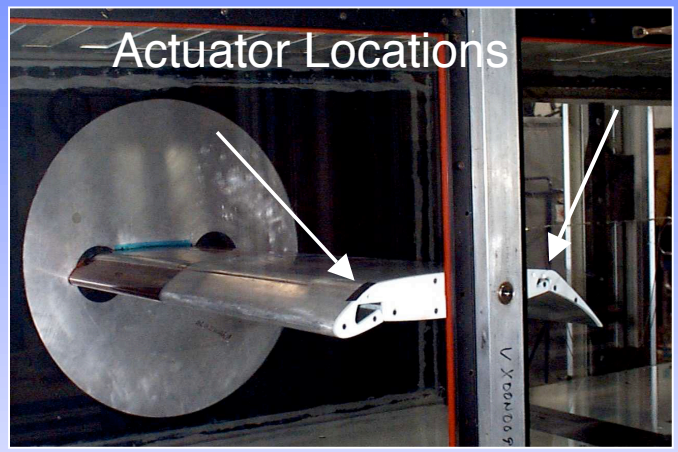


Series of four 60-min televised programs for grades 3-5

Vehicle Systems - Accomplishments

Large-scale, realistic airplane model in wind tunnel

Separation Control Using Oscillatory Blowing



Demonstration F-15 Gen 1 Intelligent Flight Control System incorporated into the C-17 Simulation

Aeronautics Blueprint

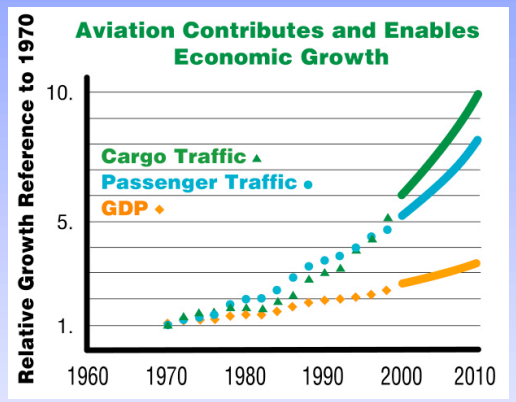
Aviation is Critical to the U.S.

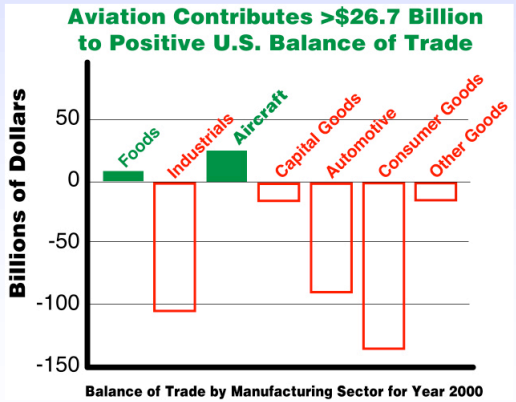
Toward A Bold New Era of Aviation: 2002 2005 2008 2009 2012 2018 2025

Economic Growth
- Productivity
- Global Competition
- Fullest Commercial Use

National Security
- Air Superiority
- Global Mobility

Quality of Life
- Freedom of Movement
- General Welfare

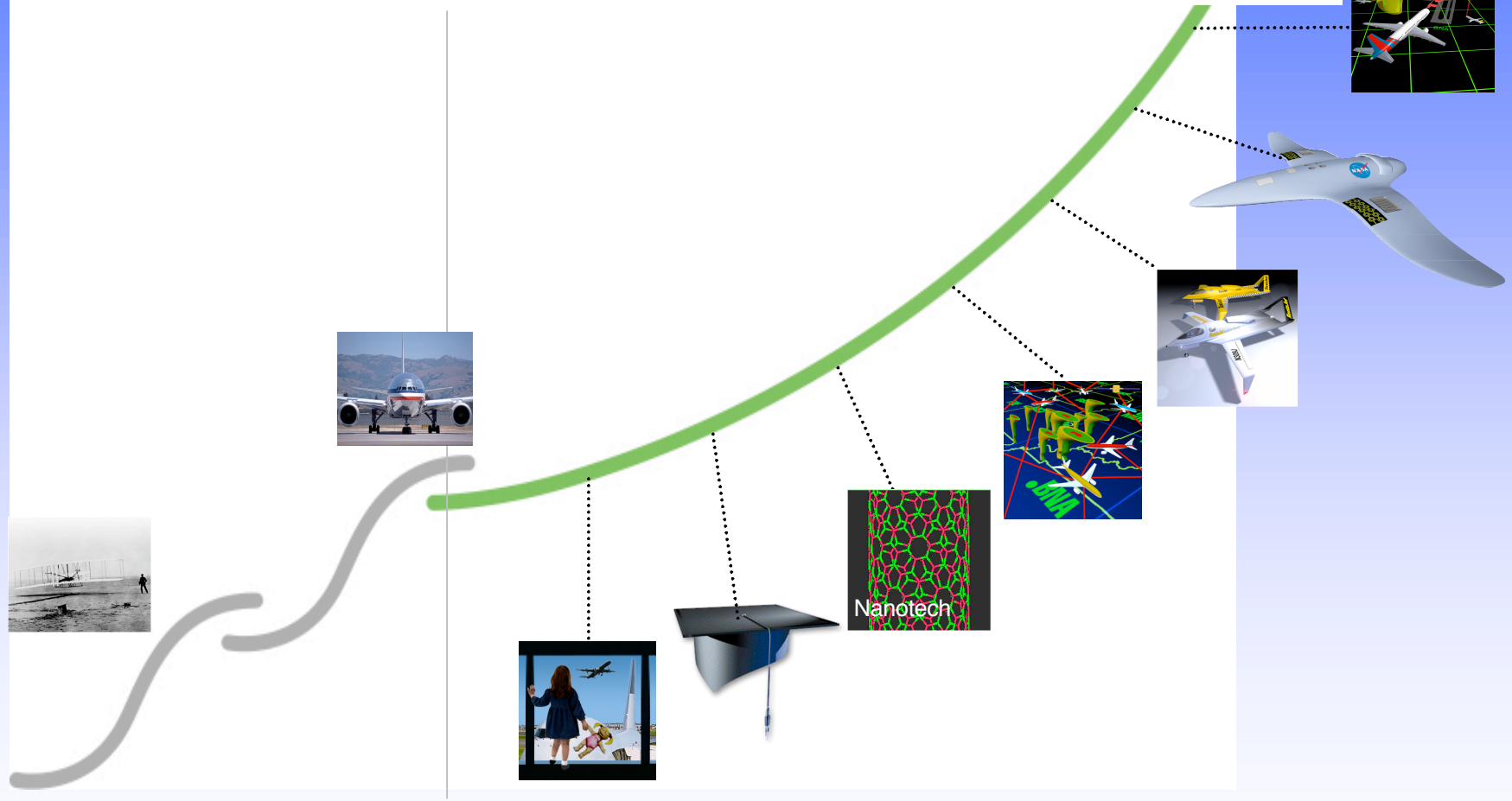




Aeronautics Blueprint

Aviation's Future is Driven by Technology

. . . and will take us to a bold new era of aviation



A Bold New Era of Aviation is Possible

Arrivals

Airline	Flight	City	Time	Gate	Remarks
Continental	1006	Key West	10:15am	B1A	On Time
TWA	5335	Miami	11:48am	A1A	On Time
UNITED	59	New York JFK	1:25	A2	On Time
UNITED	670	Cleveland	11:50am	B5	On Time
Delta Air Lines	263	Newark	10:49	B1	On Time
Delta Air Lines	9280	Tampa	12:53pm	B1A	On Time
NORTHWEST	401	Albany	11:03am	B9	On Time
NORTHWEST	2015	Atlanta	10:14am	B2	On Time
US AIRWAYS	2439	Boston	10:40am	B4	On Time
US AIRWAYS	401	Cincinnati	11:03am	B9	On Time

■ On-Time–All the Time

■ Freedom of Mobility, Access to Communities Large and Small

The New Times

National Edition

VOL CLI.... No. 51,951 WEDNESDAY, NOVEMBER 28, 2001 ONE DOLLAR

Six Communities Vie for New Neighborhood Airport

ADVANCED TECHNOLOGY ELIMINATES AIRPORT EMISSIONS

Advances in evolving technologies have the potential to change aviation in a way that will dwarf achievements of the past. Imagine having on-demand as well as scheduled air mobility, not just to hundreds, but to thousands of communities throughout the nation and the world; traveling where we want, when we want, faster, safer, and with far fewer delays; having access to rural areas no matter how remote; and having direct access to urban centers no matter how congested.

Imagine the ability to provide same-day delivery of personal packages from any place of business to any address.

Imagine projecting our military might from bases in the United States to hot spots anywhere on the globe the same day as conflicts arise; and deploying surveillance devices to

Today's aviation system is a system of systems. It is complex and highly integrated, involving some of the most advanced technologies produced by our contemporary society. The interrelationship of the many systems that make up

Today's aviation system is a system of systems. It is complex and highly integrated, involving some of the most advanced technologies produced by our contemporary society. The interrelationship of the many systems that make up

ADVANCED TECHNOLOGY REDUCES NOISE TO WITHIN THE BOUNDRIES OF THE AIRPORT

Today's aviation system is a system of systems. It is complex and highly integrated, involving some of the most advanced technologies produced by our contemporary society. The interrelationship of the many systems that make up aviation for technology evolved throughout the 20th century.

This system incremental evolution has produced an economical, effective mode of transportation systems for passengers and cargo with a safety record unmatched among all other modes of transportation. Initially, human investment and ingenuity were the only bounds to growth in aviation. More recently, system expansion has encountered real and difficult for the next physical constraints. The capacity of the Air Traffic

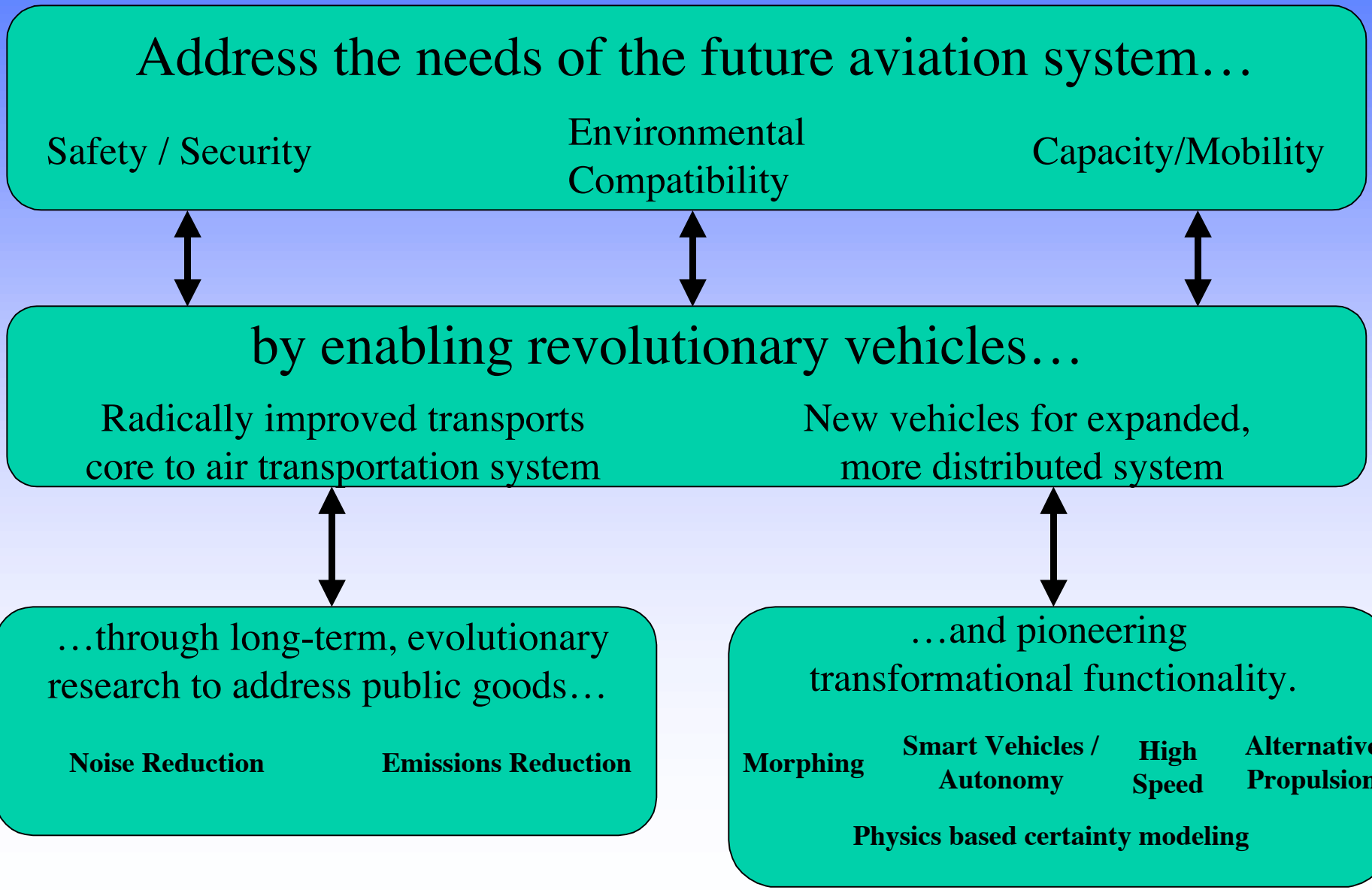
■ Clean, Quiet, Good-Neighbor Airports

■ Aviation Security and Safety

■ Meeting the Changing Threat

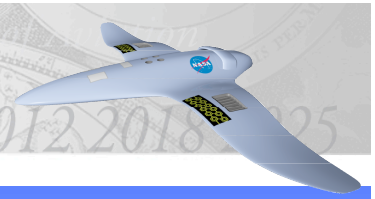
■ New Choices in Personal Air Transportation

Vehicle Systems Program Strategy



Aeronautics Blueprint

Revolutionary Vehicles–Capabilities

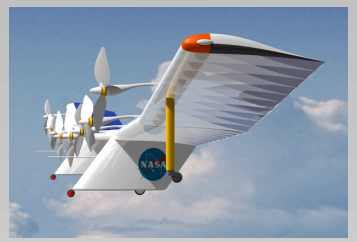


Toward A Bold New Era of Aviation: 2002 2005 2008 2009 2012 2018 2025

Today's Challenges:

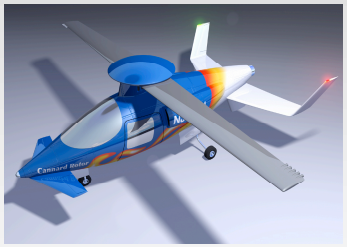
- **Long-duration and large, long-haul transportation**
- **High-speed commercial transportation**
- **Quiet and efficient runway-independent aircraft**
- **Autonomous operations capability**

Future Possibilities:

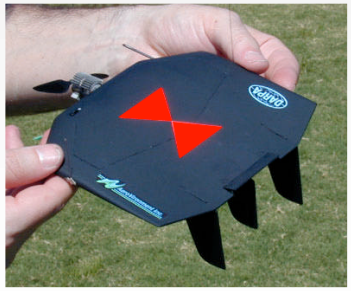


- Months aloft at high-altitudes and long distances

- Quiet, efficient, affordable supersonic flight

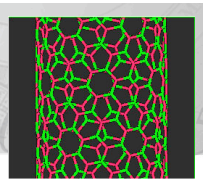


- Extremely short takeoff and landing–doorstep-to-doorstep



- Intelligent flight controls, micro-vehicles to transports

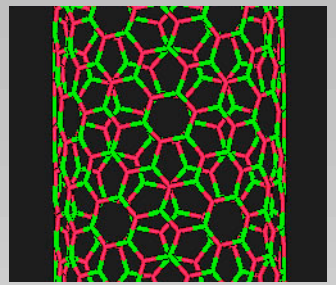
Revolutionary Vehicles–Technologies



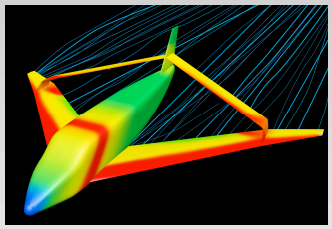
Today's Challenges:

- **Develop light, strong, and structurally efficient air vehicles.**
- **Improved aerodynamic efficiency.**
- **Design fuel-efficient, low-emission propulsion systems.**
- **Develop safe, fault-tolerant vehicle systems.**

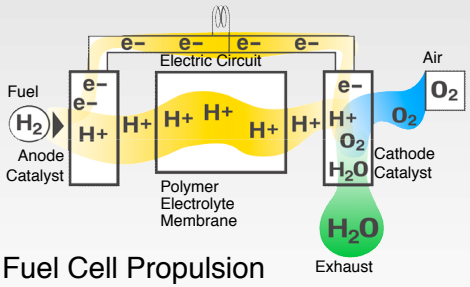
Technology Solutions:



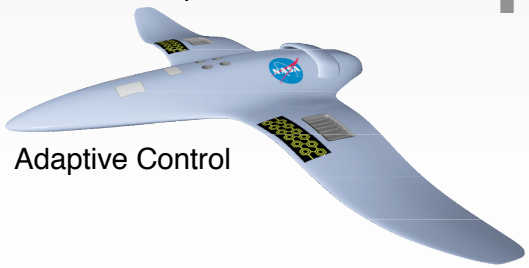
Nanotube



Active Flow Control



Fuel Cell Propulsion

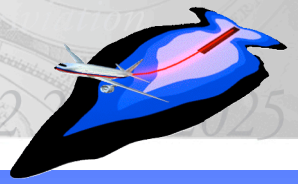


Adaptive Control

- **Nanostructures: 100 times stronger than steel at 1/6 the weight**
- **Active flow control**
- **Distributed propulsion**
- **Electric propulsion, advanced fuel cells, high-efficiency electric motors**
- **Integrated advanced control systems and information technology**
- **Central "nervous system" and adaptive vehicle control**

Aeronautics Blueprint

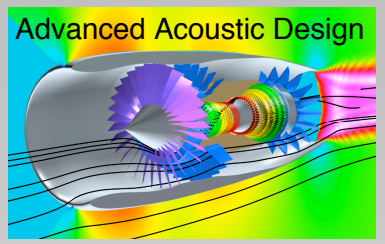
Revolutionary Vehicles–Noise



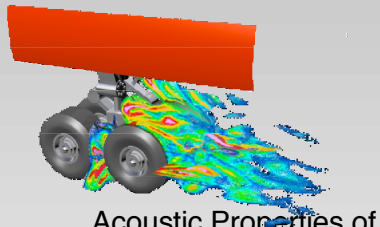
Today's Challenges:

- **Keep noise inside airport boundaries.**
  - Reduce the number of restrictions from the current 825 worldwide.
  - Eliminate the need to sound-condition homes near airports.
  - Revolutionize how citizens view airports.

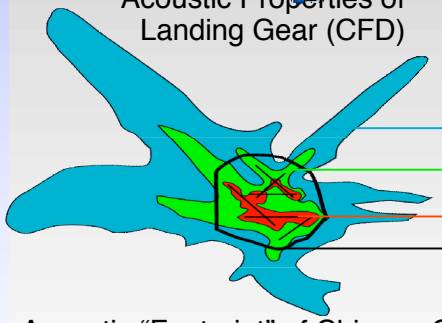
Technology Solutions:



- **Eliminate noise by improving the design of engines, landing gear, and airframes.**
  - Understand the sources of noise.
  - Integrate emerging materials, structures,and flow-control technologies.
  - Develop revolutionary vehicle designs.



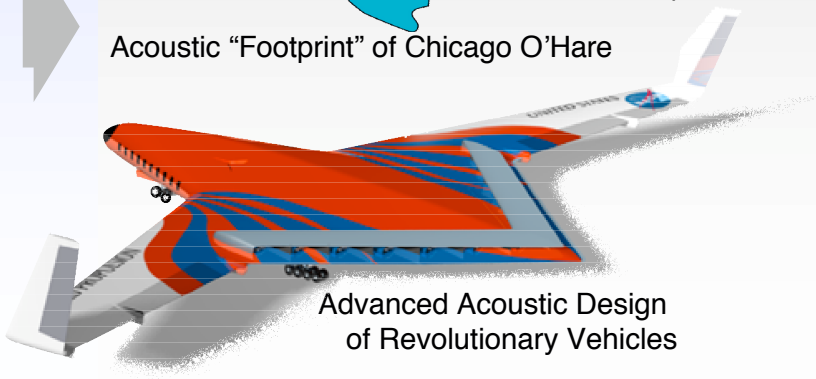
Acoustic Properties of Landing Gear (CFD)



Noise Level		People Impacted
Baseline*	=	620,000
-10 dB	=	55,000
-20 dB	=	0

Airport Boundary

Acoustic "Footprint" of Chicago O'Hare

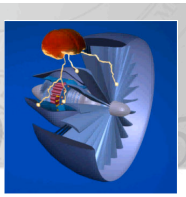


Advanced Acoustic Design of Revolutionary Vehicles

* DNL 55 is the EPA outdoor noise exposure level "requisite to protect the public health and welfare with an adequate margin of safety."

Aeronautics Blueprint

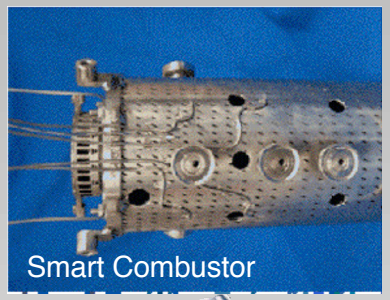
Revolutionary Vehicles–Emissions



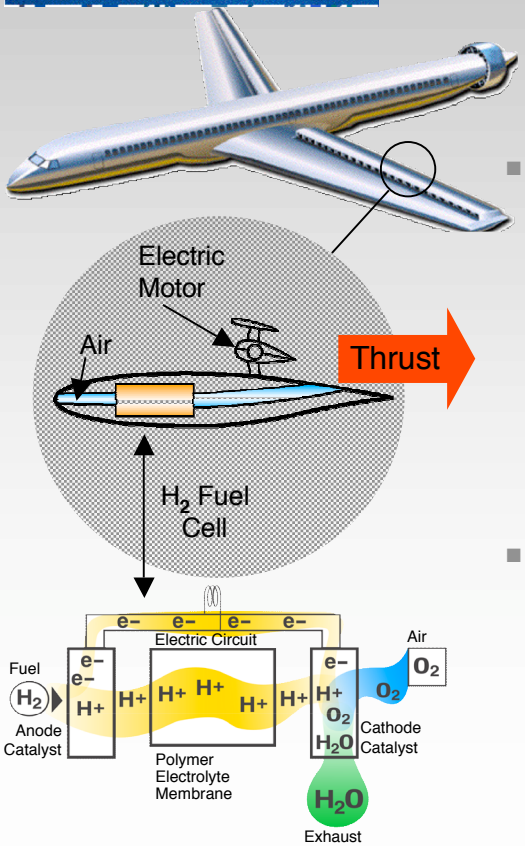
Today's Challenges:

- **Improve local air quality; reduce NO_x**
  - Projected to increase fourfold by 2050
- **Reduce impact of aviation on global air quality; reduce CO_2**
  - Projected to increase threefold by 2050

Technology Solutions:



- **Intelligent combustors**
  - Sensors and actuators to control the combustion process
  - Smart materials

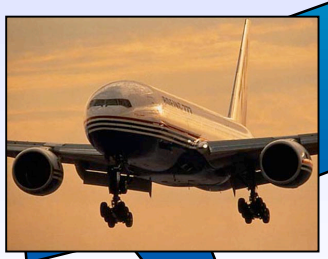


- **Increased fuel efficiency**
  - Ultra-lightweight and efficient aircraft
  - Dual-fan engines
  - Distributed propulsion
- **Electric propulsion**
  - Fuel cells
  - Global hydrogen generation and distribution

Vision for Subsonic Transports
Safe, quiet, clean, competitive, and convenient scheduled air services

Key Capability Drivers:

- Low noise
  - 55 dB footprint inside the airport boundary
- Clean
  - Very low/no emissions
- Economically competitive
  - In terms of cost to the consumer and versus foreign competition
- Convenient
  - Faster, more frequent scheduled service
- Safe, healthy & comfortable

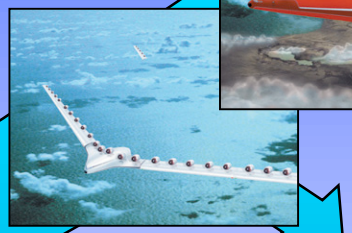


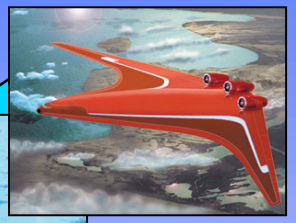
BASELINE

State of the art technology for current transports

Demonstrated Capabilities:
- Multi-functional wing structure (loads, shape, sensors, antennae)
- Limited all-weather autonomy

Demonstrated Capabilities:
- Multifunctional vehicle structure
- Ultra-efficient configurations
- Robust re-configurable controls
- STOL / SSTOL
- Programmed autonomous travel





Demonstrated Capabilities:
- Reliability-based design
- Multifunctional structure with integrated propulsion
- Vehicle is an integral node within the Airspace System
- Alternative fuels/propulsion
- Fully autonomous travel with system managers

Advanced Transport Mission:
- Small to very large capacities (50-800+ passengers)
- Short to long-range (500-9000+ nmi)
- Inherent Multi-Mode Operation
- Maximum utilization with minimum environmental impact (20+ hours/day)

2000 2025